with increasing distance from the region of precipitation.

We may, on the other hand, suppose that there are everywhere other influences opposing or neutralising the ion of electricity in the direction of the electric field; so that no earth-air current results. Geitel has offered an explanation of the maintenance of the electric field in fine weather based on a difference between positive and negative ions which was discovered by Zeleny. Negative ions are more mobile than positive, they travel with greater velocity in an electric field and diffuse more rapidly. In consequence a body exposed to a current of ionised air becomes negatively charged; Geitel suggests that the surface of the earth may acquire its negative charge in a similar way. The difference in the velocities of diffusion of the positive and negative ions could not, however, maintain an electric field except close to the ground, unless air currents were present to carry up the positively charged layers produced at the earth's surface.

It is quite conceivable that we may be driven to seek an extra-terrestrial source for the negative charge of the earth's surface. The study of the aurora borealis has led several observers to the conclusion that the sun emits kathode rays, which are deflected by the earth's magnetic field, and travel in helical paths round the magnetic lines of force towards the poles. It is conceivable that very penetrating rays of this type (*i.e.* negatively charged electrons) may traverse our atmosphere unabsorbed, and be stopped in the solid mass of the earth, giving to it their negative charge.

We have now to consider the electrical phenomena accompanying precipitation. As already indicated, precipitation is nearly always associated with the occurrence of negative values of the potential gradient. Heavy showers of rain, snow, or hail are accompanied by rapid alternations of high positive and high negative values of the electric field, generally too high to be measured by electrograph apparatus arranged to suit fine weather conditions. In extreme cases we have thunderstorms. There are cases of rain not associated with negative potential gradients; these are practically all cases of slight rain, generally mere wet mist or drizzle. Clouds from which rain is not falling rarely show marked electrical effects. To find by direct observation whether rain is charged with electricity is a matter of extreme difficulty. Elster and Geitel's observations appear to show that raindrops are charged, and that the sign of the charge frequently changes during a shower, negative values, however, on the whole prevailing.

The following are possible factors in the production of the intense electrical fields which accompany heavy showers.

A less degree of supersaturation is required to make water condense on the negative than on the positive ions (C. T. R. Wilson, *Phil. Trans.*, vol. cxciii. p. 289). Thus, if condensation takes place from the supersaturated condition, the drops formed are likely to be negatively charged; that the drops, formed in ionised air by expansions slightly exceeding that required to cause condensation on negative ions, are actually negatively charged has been proved by H. A. Wilson (*Phil. Mag.*, April). Since, however, each drop will only carry the very small ionic charge, the electrical effect will be small if only a few large drops are formed; if a large number of negative ions serve as nuclei of condensation, the drops will be small, and will only fall slowly relatively to the air; the resulting electric field cannot exceed that which drives positive ions downwards as fast as the negatively charged drops fall under the action of gravity. The field initially produced may, however, be strong enough to induce coalescence of drops which come in contact (Lord Rayleigh, Roy. Soc. *Proc.* xxviii. p. 406), and we may thus get drops carrying many times the charge of one ion, and large enough to fall rapidly. Strong fields may then result.

Again, we should expect (NATURE, vol. lxii. p. 149) drops falling through ionised air to become negatively charged as a result of the difference in the mobility of the positive and negative ions. This effect has, in fact, been experimentally demonstrated by Schmauss (*Ann. d. Physik*, vol. ix. p. 224).

If collisions resulting in splashing occur between raindrops (and they are likely to be frequent in the uprush of air in thunderstorms), positively charged rain may be formed. For, as Lenard has shown, when splashing of pure water occurs, as, for example, in waterfalls, the air in the neighbourhood acquires a negative, the water a positive, charge.

Apart from the Lenard effect, the splashing resulting from the collision of drops in an electric field may have large effects, either in intensifying or diminishing the electric field already existing, the action being like that of an electrostatic influence machine. The result would be to increase the intensity of the field if the splashes were thrown out from the lower portion of the combined drop. If, for example, the field were such as to produce positive electrification on the lower surface of a neutral drop, a droplet leaving the lower surface would be positively charged, and being carried upwards by the air relatively to the large drop, would add to the intensity of the primary field.

C. T. R. WILSON.

RAINFALL AND RIVER FLOW IN THE THAMES BASIN.[1]

THE Water Committee of the London County Council in December, 1902, called upon their chief engineer for a report on the diminution of the volume of water in the Thames and Lea, and his report was submitted to the Council in February. It deals briefly with the geology of the Thames and Lea basins so far as geology affects waterworks engineering, and in greater detail with the rainfall and the flow of the streams. The general result of the inquiry is thus stated:—

"For the past twenty years there has been a decline over the Thames watershed of an annual average of nearly $2\frac{1}{2}$ inches below the mean rainfall of 28.50 inches, as computed by the late Mr. Symons for the forty years 1850–89; and I may add that this diminution has become more accentuated during the last five years. This decline is reflected in the diminished flow of the river as gauged at Teddington Weir, the natural flow having fallen to an average of $1110\frac{1}{2}$ million gallons daily at the intakes for the 20 years compared with 1350 million gallons over the 1850–89 period, showing a loss to the river of $239\frac{1}{2}$ million gallons per day. As the diminished rainfall of $2\frac{1}{2}$ inches equals 105 million gallons per day (after making an allowance for evaporation, &c., of roughly 70 per cent.), and the above diminished flow of $239\frac{1}{2}$ million gallons shows a difference from this of $134\frac{1}{2}$ million gallons daily, it would appear as though the condition of the river was becoming more acute, inasmuch as more rainfall would be required year by year to produce the long-period average rate of flow; in fact, what this means is that the percentage of total rainfall which reaches the river is diminishing as well as the total rainfall itself. Of course, against these facts we have the possibility of a long series of wet years, which

[1] London County Council. Shrinkage of the Thames and Lea Report by Maurice Fitzmaurice, C.M.G., Chief Engineer. Pp. 18; plates. (London: P. S. King and Co., 1903.)

may bring back the state of affairs which existed on the average during the long period mentioned."

The fact that we are at present in a period of relatively low rainfall is, of course, well known, and as regards the Thames Basin, the following table is quoted, giving the average annual fall deduced from twenty-four well-distributed stations:—

Year	Inches	Year	Inches	Year	Inches	Year	Inches
1883 ...	28·41	1888 ...	28·45	1893 ...	22·08	1898 .	22·07
1884 ...	22·90	1889 ...	25·65	1894 ...	32·33	1899 ...	24·78
1885 ...	29·15	1890 ...	22·81	1895 ...	26·32	1900 ...	27·88
1886 ...	31·07	1891 ...	33·31	1896 ...	25·82	1901 ...	23·47
1887 ...	21·32	1892 ...	23·02	1897 ...	27·79	1902 ...	21·91

The report points out that the mean rainfall for the ten years 1883–92 was 26.60, and for the ten years 1893–1902 it was 25.44, or more than an inch less. But it is not clearly pointed out that the means of the four consecutive periods of five years give the respective values 26.57 in., 26.65 in., 26.87 in., and 24.02 in., in other words, that on the whole the rainfall was increasing slightly for fifteen years, and fell sharply in the last five. Nor is attention called to the fact that the average rainfall of 28.50 inches for the Thames Basin was arrived at by Mr. Symons in 1893 from the consideration of a much larger number of stations than the twenty-four on which the subsequent values are based, for the ten years 1880–89, which period Mr. Symons showed probably gave the same mean value as the long period 1850–89. It is probable that the latter figures represent the average rainfall of the basin as accurately as so small a number of stations can, and they are at least comparable *inter se*, but it is by no means so sure that they can fairly be compared with the earlier mean value obtained by the consideration of a much larger number of stations. In fact, we are not inclined to look upon the decline in the rainfall as quite so serious as it appears to be from the report, and we are confident that in the course of time, and probably in a comparatively short time, the fall will again reach the average.

The report shows plainly that the diminution in the flow of the Thames (and the same holds good of the Lea) is greater than the diminution of the rainfall. Theoretical considerations suggest that this is what should occur, for the amount of water absorbed by vegetation must be approximately constant, and in a dry year evaporation is usually more active than in a wet one, while, when the water-level in the pervious rocks is lowered, the flow of springs cannot respond to the rainfall with the promptitude usual when the rocks are saturated.

It is a matter of regret that hydrology, as applied to the rivers of the whole British Isles, has not been taken up by any Government department. This report of the County Council shows the interest of the problems involved, and it may be that a more systematic treatment of statistics of rainfall and river-flow would answer the questions which is suggests.

HUGH ROBERT MILL.

ARCTIC GEOLOGY.

AS the report on the geological observations made during the recent Polar expedition of the *Fram*, recently read before the Royal Geographical Society by Mr. P. Schel, of which we have received a separate copy, is only a preliminary one, and the geological terms employed require some revision to make them intelligible to an English reader, a brief notice may suffice, though evidently the results will be very valuable. Under Captain Sverdrup's leadership, Ellesmere Land was crossed, part of its southern and its western coast was traced, with the corresponding side of Grinnell Land, and journeys were made round Axel Heiberg and Ringnes Islands. The collections obtained, which were often considerable, show that the region explored, with the newly discovered islands, consists of formations which were known to occur on the two sides of Smith Sound and on the long chain of islands extending on or near the seventy-fifth parallel from North Devon to Prince Patrick Island, viz. a foundation of crystalline Archæan rocks, largely granitoid, followed by sedimentaries the oldest of which are of Cambrian age, the part immediately following the Archæan being occasionally, as might be expected, an arkose. In some places representatives of the Ordovician and Silurian occur, and, as in the other islands, Devonian and Carboniferous, including the representative limestone, are extensively developed. Mesozoic formations are represented, but apparently on no great scale, and large masses of sandstone, with lignites and shales, are identified by their plant fossils as Tertiary (Miocene or perhaps rather earlier), as in Greenland. In parts of Ellesmere Land and Heiberg Island are various eruptive rocks, porphyrites and diabases, cutting the Archæan and the older sedimentaries. Basalts and dolerites occur in Grinnell Land intrusive in Mesozoic strata, and surface lavas and somewhat similar rocks overlie Carboniferous rocks in Heiberg Island. They are older than the Tertiary shale mentioned above. The region has occasionally been much faulted, and locally crushed up against a "horst" of Archæan rock. It has also been affected by earth movements of late date, indicated by raised beaches and marine terraces, which are at various elevations up to nearly 600 feet, and so prove that the land has risen. There are no large masses of inland ice or signs of glaciers having formerly been on a much more extensive scale than at present. This is probably due, at any rate partly, to a rather small precipitation.

J. V. LABORDE (1830–1903).

DR. LABORDE (Jean Baptiste Vincent), who died recently at the age of seventy-two, was born at Buzet (Lot et Garonne), and received a good education at the Lycée of Cahors, after spending some time in a boarding-school at Casteljaloux. To satisfy his natural bent for medical studies he went to Paris, without any resources, and, in order to provide for his livelihood and his studies, he was obliged to give private lessons. However, he managed to be appointed *externe des hopitaux in* 1854, in the same promotion as Lancereaux, now president of the Académie de Médecine. Four years later, he obtained the *internat*, in which capacity he spent four years more in the hospitals of Paris, after which he was graduated doctor médic. for his thesis on "La Paralysie Infantile" (1864). Meanwhile he had obtained the gold medal of the hospitals, the Corvisart prize, and another prize from the Société Médicale des Hopitaux, and, lastly, in the very year in which he got his doctor's degree, the Godard prize, awarded by the Société Anatomique de Paris.

In 1872 Laborde gave up pure medicine to devote himself to scientific works, particularly to physiology, giving to his researches a solid and safe basis, by means of the experimental method. At first only an assistant to Prof. Béclard, he was soon appointed chef des travaux de physiologie at the Faculté de Médecine, and for many years the demonstrations he gave in his laboratory were attended by numerous pupils. It was in the course of this period that he published the